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Aquatic Life: With Special Reference to Entomostraca.

BY JOSEPH STACK.

The present paper is the result of a zoological survey of Beimiller's Cove, Cedar Point, Ohio, and of numerous ponds and streams in that vicinity, nearly all the work being done on invertebrate forms. The chief problem was on the habitat of Entomostraca and the environic conditions affecting them. The forms most abundant in the cove, and most often observed, belong to the two sub-classes *Phyllopoda* and *Copepoda*. The nauplius stage was considered by itself at all times.

During the summer, several trips were taken to neighboring bodies of water and the data gathered on these trips is included in this survey.

Cedar Point is a peninsula, not over one mile wide at its widest point, extending eastward for seven miles into Lake Erie from the north-central part of Ohio, separating Sandusky Bay on the south from Lake Erie on the north. Cedar Point proper is located at the end of this peninsula and Ohio State University Laboratory is located two miles east of Cedar Point on Beimiller's Cove, at which place most of this survey was made.

Beimiller's Cove is situated in an ideal place for studying aquatic life. It is separated from Lake Erie on the north by Cedar Point, which is one quarter of a mile wide at this place. On the south it is separated from Sandusky Bay by a narrow peninsula about one half mile long which is an extension from the Point proper. The west portion of the Cove cuts into the Point ending in a marsh. The Cove opens into Sandusky Bay on the southeast side. With such aquatic surroundings the opportunity for a comparative study is unlimited, a point that will be considered in the survey.

To obtain more accurate data on the habitat and environic conditions affecting the Entomostraca in Beimiller's Cove, stations were established where different environmental conditions prevailed and these places were subjected to careful study. These stations were visited every day and the day following the visits was spent in the laboratory identifying and determining the specimens collected. On account of the large area of the Cove it required a whole day to make the complete trip to all the stations.

Station I is located in the extreme north-west corner of the Cove and marked by a long pole driven solidly into the bottom at this place. The water is very shallow, 1¾ feet deep. The bottom is covered with decomposed plant life, consisting chiefly of water lily pads and bulrushes. Owing to the shallowness the temperature of the water varies directly with atmospheric changes. As in all shallow water, the temperature remains constant or usually tends to constancy throughout the slight depth according to the changes of air temperature. The shore at this point is covered with ferns and short grasses forming a swampy undergrowth. Owing to this form of vegetation there is little protection from the sun.

Station II is similarly situated near the shore which is swampy and sparsely protected by shade. The water is slightly deeper than at Station I, being 2⅔ feet deep. Other characteristics are similar to Station I. A large water-soaked log extending from the swamp makes a very stable land mark for this station.

Station III is one of the most interesting points studied, being located in the mouth of a sewer channel which carries all the sewage from Cedar Point and empties part of it into the Cove. The remainder is carried, by a deepening of the channel to 4 feet, into Sandusky Bay. Station III is located in the extreme south-west corner of the Cove at the entrance of the sewer channel into the Cove. At this point the water is 3 1-6 feet deep and is extremely turbid, caused by sewage. There is a decided current produced here and continues to the Bay owing to the fact that the channel is several feet deeper than the surrounding water of the Cove. Due to this and to the great force that propels the sewage into the channel, the current is very strong and vegetation is not given a chance to grow as it does in the quiet water of the rest of the Cove. This current produces a fluctuation of forms and numbers at this station. The bottom is covered with a deep black slime. The water is protected from the sun by shrubs and small trees extending from the bank of the peninsula on the south.

Station IV is midway between Station III and the end of the Cove on the south side, being too far from the sewer channel to be noticeably affected by it. The bank slopes gently to a height of about 5 feet on the top of which there is a slight second-growth of trees which furnish considerable shade for this station. The bottom is rather sandy and free from abundant vegetation and is gradually sloping in toward the center of Cove. Depth is 2 feet; marked by tree on peninsula.

Station V is one of the deepest parts of the Cove, 5⅔ feet deep. The bottom is covered with a deep, soft layer of sandy loam on which grows an abundance of vegetation, chiefly *Myriophyllum* and *Ceratopyllum* which grows so rapidly that by August 25th it is impossible to row a small boat through the Cove. These forms first start submerged and later cover the entire surface. This station being located in the center of the Cove is noticeably affected by wind and currents. In early summer, before the vegetation has become too abundant, the water is clear.

Station VI is south-east of Station I on the same side of Cove. The bottom is covered with decomposed plants making a mucky covering over sand. Underbrush covers the shore, back of which is a small wood which furnishes shade to the shore at this station. It is 1⅓ feet deep; marked by dead tree on bank.

Station VII is located about 10 feet south of Laboratory Point in a swampy region, the water being 1¾ feet deep. The bottom is composed of sand covered with muck. The shade is sparse.

Station VIII is midway between Laboratory Point and the end of the peninsula on the south, at the opening of the Cove into Sandusky Bay. This is the deepest part of the Cove, 6½ feet. There is abundant vegetation as at Station V. The bottom is mucky and the wave action quite pronounced. No shade.

Station IX is near the shore, at the extreme east end of the narrow peninsula on the south. The water is shallow at this point being only 1 1-6 feet deep. The bottom is sand covered with scant vegetation. The peninsula ends at this point as a sand bar.

All observations and collecting was done by the aid of a big, heavy, flat bottomed row boat which was 12 feet long and 3 feet wide, having very low sides. It had to be quite large in order to carry the necessary equipment, to give ample room for taking the readings, and for preparing collected material for safe transportation to the laboratory. The heavier the boat the less chance for drifting from the point of operation. Having a flat bottom there was very little chance of rocking and it presented a plain surface on which could be placed bottles, jars, etc. Having low sides, 5 inches above the water surface, it facilitated the work of handling the nets, taking temperature readings and making observations along the bottom.

The carbon dioxide content of the water was determined by titration. On the seat in the stern of the boat was carried a case which contained all the requisites for making the analysis of carbon dioxide content. It contained a small bottle of indicator to which was attached a tube with a spring clamp which kept the bottle air tight and facilitated the using of the indicator. Another bottle similarly equipped contained sodium hydroxide. A test bottle was lowered to the bottom of the Cove by means of a long, stout cord. To the neck of this bottle a weight, heavy enough to submerge it, was attached. To the cork was fastened a stout cord by means of which the water-tight bottle could be opened after it had reached the desired depth. The carbon dioxide content was taken as follows: the test bottle was made as free from air as our means would permit and the stringed-cork tightly inserted. The bottle with weight and cord attached was lowered into the water to the desired depth and the stringed-cork was pulled allowing the water to enter until the bottle was completely filled. Then it was drawn gradually to the surface and corked to keep the air from entering. Before the titration was made the top portion was quickly poured off to obtain more accurate results and 1000 c. c. taken from the remainder. To this a few drops of indicator was added drop by drop and the number of c. c. required to color the solution a delicate pink determined the amount of carbon dioxide present in 1000 c. c. of water. On a following page the results are given. These readings were made only on two trips owing to the amount of time it required to make them and to the fact that the presence of the carbon dioxide was practically constant for the length of time we were working on this problem.

All temperatures were taken by means of an accurately adjusted and tested deep sea thermometer. Four readings were taken at the nine stations every trip; air and water temperature at the surface, water temperature one half distance to the bottom, and on the bottom.

The turbidity was taken by the use of a very simply constructed turbidimiter made of a Mason jar cover in the top of which was the customary porcelain disc. To the sides to this cover were attached three strings which were tied at a point 4 inches above the cover. This method of attachment kept the white porcelain disc parallel to the surface. From the three strings extended a long extension which was used for lowering the cover from the boat. The turbidimiter was lowered in a horizontal position and the depth at which it entirely disappeared from view was noted. It was then slowly raised again and the depth at which it reappeared noted. The mean of these two measurements was taken as the depth of its visibility beneath the surface. This turbidimiter was used at each station.

For collecting purposes towing nets, made of fine silk bolting-cloth were used. These nets were 18 inches long and conical, the base or entrance being 8 inches in diameter, and held open by a wooden hoop. Three cords were attached by the same method used on the turbidimiter. The apex or outlet of the net was ½ inch in diameter and to this end was tied a small vial 2 inches long and ½ inch in diameter. On the neck of each vial there was a flange which facilitated the tying on of the net. Fifteen of these collecting vials were used on each trip and were carried in a box specially made for them. New corks were always used and at each station the date, number of towing, and a letter representing the kind of towing was written with water proof ink on each cork which was then inserted into a corresponding vial. See chart number 1 for method of keeping this data.

Field notes were kept in a water-proof covered notebook and the form on the following page was used in recording observations at each station.

Date................, 1916. Time of day............. Air temperature.............
Wind: Direction............. Velocity............. Water Temperature: Surface
.... ½ distance to bottom........ .... Bottom............. Sky............. Turbidity............. Carbon dioxide.............per 1000 c. c. Bottom condition.........

The following terms were used for description ot:

Wind.	
Not perceptible	N. P.
Calm	C.
Moderate	M.
Light Breeze	L. B.
Strong Breeze	S. B.

Sky.	
Clear	Cl.
Hazy	H.
Cloudy	Cd.
Foggy	F.

Plant Life	
Abundant	A.
Sparse	S.
Absent	Abs.

Character of Bottom.	
Sandy	Sn.
Mucky	My.
Clayey	Cly.

On each trip it was necessary for one man to row the boat and keep notes while the other made the observations. To avoid variations in the readings the same man made all the observations while the other rowed the boat.

We usually started out at 9:30 a. m., and at each station the following procedure was carried out. On arriving at the station a heavy anchor was dropped to the bottom to hold the boat at a fixed point. Then the form for keeping the data, previously described, was filled out. The towings were made as follows: first the tow net with vial attached was weighted and buoyed sufficiently to emerse the net and vial to the desired depth. This was attached to a rope 100 feet long. The boat was then rowed 100 feet and then anchored and the net with vial was gently pulled to the boat. This gave us sample No. 1, horizontal towing at the surface. The cork was marked accordingly and inserted into the vial. A note of vial was made in record book. Owing to the shallow water at some of the stations only the one towing was taken but at other stations where the depth of the water was greater, the surface, one half the distance to the bottom and bottom towings were taken and marked accordingly. The complete trip was generally finished at 3.00 p. m., and the material brought to the laboratory for preserving. Four drops of formaldehyde and two or three of glycerine to each vial served as best preservative. The vials were placed on a special, private table and were not molested. The examination of material was made next day.

FIELD NOTES

CHART I

Date....6-29-16. Time....9:32 A. M. Sky....Hazy.

Station No.	I	II	III	IV	V	VI	VII	VIII	IX
Cent. Temp. at Surface	27.5	27.5	29.	28.	28.	28.5	28.	27.	27.
½ Dist. to Bottom	27.5	27.	29.	28.	28.5	28.5	28.	27.	27.
Bottom	27.5	27.	28.5	28.	26.	28.	28.	26.	27.
Depth	1′9″	2′8″	3′2″	2′	5′8″	1′4″	1′9″	6′2″	1′2″
Time	a. m. 9:45	10:00	10:20	10:40	p.m. 1	2	2:15	2:30	3
Wind Direction	N.W.	S.W.	S.W.	S.W.	S.W.	S.W.	S.E.	S.E.	S.E.
Wind Velocity	L.B.	L.B.	L.B.	L.B.	L.B.	L.B.	L.B.	S.B.	S.B.
Turbidity	1′9″	2′8″	8′	2′1″	3′8″	1′8″	1′9″	3′1″	1′2″
Air Temperature	27	27	27	27	26	26	26	26	25
CO_2 Cont. No. c.c. perM.	3	0	20	2	10	0	0	7	2

Vial No.	*Location*
I	Horizontal Towing from station I.
II	Horizontal Towing from station II.
III	Horizontal Towing from station III.
IVa	Horizontal Towing at surface from station IV.
IVb	Horizontal Towing ¼ D. to B. from station IV.

IVc	Horizontal Towing at bottom from station IV.
Va	Horizontal Towing at surface from station V.
Vb	Horizontal Towing ¼ D. to B. from station V.
Vc	Horizontal Towing at bottom from station V.
VIa	Horizontal Towing at surface from station VI.
VIb	Horizontal Towing ¼ D. to B. from station VI.
VIc	Horizontal Towing at bottom from station VI.
VIIa	Horizontal Towing at surface from station VII.
VIIb	Horizontal Towing ¼ D. to B. from station VII.
VIIc	Horizontal Towing at bottom from station VII.
VIIIa	Horizontal Towing at surface from station VIII.
VIIIb	Horizontal Towing ¼ D. to B. from station VIII.
VIIIc	Horizontal Towing at bottom from station VIII.
IXa	Horizontal Towing at surface from station IX.
IXb	Horizontal Towing ¼ D. to B. from station IX.
IXc	Horizontal Towing at bottom from station IX.

A qualitative and quantitative microscopical analysis was made of the contents of each vial. Three slides were made from each sample and the kinds and quantity of forms noted. The average number of each form on three slides was recorded as on Chart II.

6-29-16

CHART II

Vial No.	Bacteria	Algae	Diatoms	Arcella	Nauplius	Bosmina	Cyclops	Cypris	Chydorus	Simocephalus	Daph'a
I	sparse	sparse	0	1	6	12	38	14	12	12	2
II	sparse	sparse	6	3	23	0	5	5	3	0	0
III	abundant	absent	20	0	45	0	9	2	10	0	0
IVa	abundant	absent	2	2	9	4	24	11	0	3	7
IVb	abundant	present	12	8	2	2	14	19	10	8	1
IVc	sparse	present	10	6	5	17	6	3	12	1	0
Va	sparse	present	12	5	41	5	9	0	8	0	0
Vb	sparse	abundant	0	0	7	3	4	14	3	6	2
Vc	sparse	abundant	14	8	1	2	1	10	0	2	0
VIa	sparse	abundant	4	3	48	40	34	18	12	14	3
VIb	abundant	abundant	9	7	2	12	24	16	7	5	0
VIc	sparse	sparse	18	9	7	1	9	4	0	2	0
VIIa	sparse	sparse	0	1	16	1	2	12	8	7	1
VIIb	sparse	sparse	2	0	8	1	3	8	12	3	2
VIIc	absent	abundant	5	2	7	3	0	7	0	0	0
VIIIa	absent	abundant	0	0	5	3	0	6	3	2	0
VIIIb	absent	sparse	0	0	4	2	1	1	0	3	1
VIIIc	sparse	present	7	3	2	4	6	5	3	0	0
IXa	absent	sparse	0	0	2	4	2	0	1	2	0
IXb	absent	sparse	3	6	7	10	7	6	0	5	1
IXc	absent	absent	12	15	0	3	1	12	6	0	3

Chart I represents the data taken on the following days in 1916. June 22, 23, 29. July 7, 13, 21, 24, 26, 28. August 2, 4, 8, 16, 22. On each trip a similar chart was used and at the end of the summer the average temperature, turbidity and carbon dioxide content was calculated. Chart I shows the average at each station. Thus fourteen charts similar to I and II were made, denoting fourteen trips to each station and from the data taken at each station the following conclusions were drawn.

Stations I and II. Very shallow; temperature variable; bottom covered with decomposed plant life. The Entomostraca which feed on plants, desmids, diatoms, etc., were quite abundant. The greater the rainfall the more abundant the Entomostraca at all of the stations. 3 c. c. of carbon dioxide per 1000. No effect on forms found at such a low per cent.

Station III. Comparatively deep. Carbon dioxide content high, 20 c. c. per 1000. Bacterial growth abundant. Numerous Entomostraca in nauplius stage. Adults found more numerous at Station IV where vegetation was more plentiful. The number and genera fluctuated from day to day due to the current from the sewer channel.

Station V. This station was one of the deepest in the Cove and although fewer forms were found here their number and kind were more constant. It was found by taking three horizontal towings that the Entomostraca tend to be uniformly distributed in a horizontal plane having the maximum number about 2 feet below the surface and the minimum at the bottom. The nauplius stage appeared first in the upper waters of the Cove quite near the surface. Increase in population results in extension downward, and the mass becomes most uniformly distributed at its maximum developement. With decline of production there is a relative increase in numbers in the lower waters. Common sunfish (*Eupomotis gibbosus*) were feeding on the surface forms.

Station VI. Located near shore having similar surroundings and environment that existed at Stations I and II. The forms frequently found here were Daphnia, Simocephalus, Chydorus. Sunfish had built their nests at this point and fed upon these forms. It is estimated that one *Daphnia pulex* (female) may have a progeny of 13,000,000,000 in sixty days. It is little wonder then that the Entomostraca form one of the chief foods for fishes. It was also noted that when large numbers of Daphnia occurred and a cloud would shade the rays of the sun these forms would come nearer to the surface and with the passing of the cloud the forms would descend.

At Stations VII, VIII, and IX, which were at the outlet of the Cove all the forms fluctuated owing to the wind currents producing waves. Especially was this true when the wind came from the south or the southeast. On calm days the greater numbers were found near the surface while on windy days they were entirely absent or only a few near the bottom. Very seldom was the nauplius stage found at this station.

At Stations I, II, VII, and IX, the water was shallow and the temperature remained constant or would tend to constancy throughout the slight depth, depending upon atmospheric changes. At these stations the forms were found to be numerous on warm, bright days but very few could be found on cool, dark days; at such times they were more numerous in deeper water where less fluctuations in temperature occurred. Greater fluctuations occurred in the narrow Cove which was also shallower, than in Lake Erie or in the abandoned quarry pond to be described later, both of which were considerably deeper.

This sums up only a very minute portion of such a vast problem and only a few conclusions have been drawn. In addition the following data was collected on trips taken to neighboring bodies of water and also on some other observations made in Beimiller's Cove.

BLUE HOLE, CASTALIA.

Blue Hole is located at Castalia, Ohio, which is about six miles southwest from Sandusky, Ohio, close to the Big Four R. R. tracks.

A party of four made observations and collected material from Blue Hole, July 3rd, 1916. We arrived at this place at 10:45 a. m., the weather conditions being ideal. The sky was clear, the sun hot and the wind very perceptible.

The Hole is 80 feet long, 64 wide and about 45 deep; having two small outlets about 3 feet wide, leading from either side. It is surrounded by a narrow path about 2 feet wide and surrounding this there is thick vegetation, 6 inches to 3 feet high. Extending from the bank, out about 2 feet on the top of the water there is a shelf of plant life made up of moss, chara, algae, spirogyrae, and other forms intermingling.

On this particular day we found the water to be exceedingly clear and blue. This blue color is probably due to the blue-green algae and great amount of sulphur present. The Hole is fed by springs which, on some days, bubble up to the surface. The water is ice cold and very odorous of sulphur. Workmen, who get drinking water there, say that when the springs are bubbling it is impossible to see the bottom owing to the great agitation. The sides and bottom are composed of marl and only a slight growth of vegetation occurring on the sides near the top, was found.

From the two streams leading from the Hole, numerous trout are caught every year but in the Hole itself animal life is very sparse. We could see no fish but found one stickleback underneath the plant shelf. The keeper of the Castalia Fishing Club said that he had seen trout swim across Blue Hole with mouth out of water and then jump on to the land. From these facts we drew the conclusion that there is but very little free oxygen present.

From the shelf which covered the water for about two feet from the shore towards the center, pieces of the shelf, 1 foot long by 6 inches wide, were taken from the Hole and examined. The first piece was taken from a point nearest the center of the Hole. It was made up of moss and algae. On the under surface there were found numerous snail eggs but only a few adult forms. Located in the mat there were *Gammarus* and snails. Very few forms were found on the top of the mat.

The second piece was taken from a point close to the shore and the odor from this piece was very strong of sulphur. Few forms were found on the surface and on the bottom but in the mat the following forms were found: numerous insect larvae, snail eggs, leeches and *Gammarus; Asellus* sparse, and only one earthworm.

The third sample, taken from the mat next to the shore, was made up of chara. In this the *Gammaridae* and *Asellae* were abundant. Also found *Simulium* larvae. In a piece of *Spirogyrae* mat taken from a similar point numerous *Annulates* were found.

A sample of moss taken from the Hole at the upper end had very little life on it, one earthworm being found.

Sample number 5 was taken from near the shore and was made up of mint, moss and other plants and it was found to be sparsely inhabited; a few snails, leeches, and insect larvae. Three pieces of moss, the size of the hand, were taken next and examined and the following were found:

A..............7 Gammaridae.
B..............13 Gammaridae.
C..............14 Gammaridae.

From a piece of chara the same size:

A..............3 Gammaridae.
B..............4 Gammaridae.
C..............4 Gammaridae.

The moss seemed to be the most desirable. The gray colored type which is the larger was found, as a rule, nearest the shore. These *Gammaridae* also live near the surface. Other forms found were earthworms, snails, *Asellus* (few) and *Hydrophilous* beetles (few). In the protected place along the shore a great many *Physa* were found on the algae.

On another lump of moss the size of the hand we found 21 leeches, 5 snails, 2 earthworms, 1 beetle, 10 *Gammaridae.*

From the preceeding data we drew the following conclusions:

1. Life scarce, due to lack of oxygen.

2. *Gammaridae* most numerous of forms found, being most abundant near the surface and in the plant life along the shore.

3. Algae and moss plentiful, furnishing abundant food for plankton.

Towings were taken at the surface (Tw. 1); (Tw. 2) ½ the distance to the bottom and in these the following forms were found:

Tw. 1.
Diatoms (abundant).
Spirogyrae (sparse).
Blue-green algae (abundant).
Roundworm (Nais 1).

All smaller protozoans absent. A few Desmids found.

Tw. 2.
Spirogyrae (sparse).
Cypris..................4.
Annulates...........3.
Insect larvae.......2.

On August 3rd. we took the following readings, the carbon dioxide content being taken about 10 feet below the surface:

Reading No. 1..............50 c. c. per M.
Reading No. 2..............60 c. c. per M.
Reading No. 3..............60 c. c. per M.

The depth of the water near the log on the west side is 32 feet.

The depth in the depression on the east side is 29 feet.

The temperature at the lower outlet was 41.3 F. The temperature around the shelf where the water is more stagnant than at the outlet was 60.8 degrees F.

BEIMILLER'S COVE, CEDAR POINT.

July 5, 1916.

A strip of shore water 100 feet long and 30 feet wide along the northwest corner of the Cove was examined for aquatic forms. The temperature of the water was 27 degrees C., and this was constant throughout the slight depth of 2 to 3 feet.

The flora found consisted of willows along the shore, *Myriophyllum* and *Ceratophyllum* just below the surface, roots of grasses and trees along the shore, and reeds throughout the space covered.

On the surface of the water along the shore were found adult mayflies and midges while adult *Lepidoptera* were flying over the water. There was an abundance of vegetation near the shore and this accounts for the mucky bottom at the east end of the Cove. Leeches (*Glossiphonia*) were found to be numerous and *Asellus* were abundant.

In the mud and under the surfaces of leaves and in among the roots along the shore the *Gammaridae* were numerous. Also found large egg masses of P*olyzoa*, pupae cases, *Oniscus*, leeches, and snail eggs.

On the reeds which were all growing from a sandier bottom, leeches, water mites, snails, polyzoans and snail eggs were found. On all vegetation in this locality polyzoans were found in abundance. *Gammaridae* most numerous on myriophyllum and algae.

On the bottom along the northeast side of the Cove a few mussels (*Lampsilis*), numerous snails at a depth of 2½ feet; and sunfish nests at 2 to 3 feet were found; also a few crayfish.

The air temperature during the collecting period was 27 degrees C. and the water temperature 25 degrees.

SUNFISH-NESTS—BEIMILLER'S COVE.

July 5, 1916.

The sunfish build their nests along the shore in shallow water where the bottom is unusually sandy and free from vegetation.

The nest consists of a saucer-like depression having the bottom lined with small pebbles. These pebbles may be the result of the fanning, described later on, or they may be the result of wave action.

In the process of building the nest the fish clear the desired location by swimming around and around the spot in a very methodical manner; swimming clockwise three or four times then erecting the body and using the tail as a fan or broom to clear away the vegetation and other foreign substances; then they swim counter-clockwise for three or four times and go through the same process of sweeping. At regular intervals, usually after four complete cycles, they dart out to survey the surroundings for enemies, etc.

They are gregarious in their nest building habits. We found anywhere from 6 to 14 in a colony in the Cove.

MARSH POND—KELLEY'S ISLAND.

July 8, 1916.

Large marsh pond located about 75 yards from Lake Erie. Great abundance of vegetation consisting of algae and spirogyrae. The bottom was covered with a deep mud. The following forms were found: beetles, water striders, snails, few *Gammaridae* and tree toads. Back swimming beetles, *Hydrophylidae*, *Dytiscidae;* numerous crayfish, minnows, frogs amid the vegetation, leeches and *Rhyncophoridae.*

This marsh was formerly a celery bed but now kept moist and marshy by springs and seepage from the lake.

ROCK BOTTOM POND—KELLEY'S ISLAND.

July 8, 1916.

The pond was originally a quarry and has been blasted out at least 14 years ago. It measured 100 feet wide and 120 feet long. Rocky bottomed and rock bound. Turbidity 9 inches. One corner was covered with grass and willow bushes. Abundant algae and spirogyrae around the edge.

On the surface were found water striders, *Gyrinidae*, back swimmers, *Notonectidae*, midgepupae, diptera larvae, fish, turtles, toads, leeches and snails. Also found an Oligocheat (*Lumbriculus*) close to the rocks in spirogyrae.

In a surface towing taken from a point 10 feet from the shore along the bottom the following forms were found:

Cyclops........75.
Cypris........26.

Numerous *Colpoda* which resembled *Paramecium* only smaller.

LAKE ERIE AND SANDUSKY BAY FARMS.

July 17, 1916.

Comparison of plankton in Lake with that in Bay.

No. 1 Tw. in Bay.

1. *Ceratium* (numerous).
2. *Nauplius* (numerous).
3. *Cyclops.*
4. *Annulata* (*Stylaria lacustria*).
5. *Rotifera.*
6. *Diatoms* (Asterionella).
7. *Arcella discoidea.*
8. *Bosmina* (few).
9. *Amoeba proteus.*

No. 2 Tw. in Bay.

1. *Bosmina.*
2. *Nauplius* (numerous).
3. *Cypris* skeleton.
4. *Ceratium* (numerous).
5. *Rotifera.*
6. *Peritricha* (*Podophrys*).
7. *Diatoms.*
8. *Daphnia hyaline.*
9. *Cypris.*
10. *Closterium.*

No. 1 Tw. in Lake.

1. *Monostyla.*
2. *Ceratium longicorne.*
3. *Difflugia lobostoma.*
4. *Bosmina striata.*
5. *Nauplius.*
6. *Diatoms* (Asterionella)

No. 2 Tw. in Lake.

1. *Difflugia lobostoma.*
2. *Ceratium.*
3. *Diatom.*
4. *Algae.*
5. (Fish).

From the preceeding comparison we find that the planktonts are more numerous in the Bay than in the Lake and in the Lake they are more numerous a distance out where the shore does not affect the occurrence than they are near shore. For self preservation the planktonts avoid the battering action of the waves along the shore.

PIPE CREEK, SANDUSKY.

July 19, 1916.

Pipe Creek is a typical rock-bottomed stream which begins in a marsh near the Bay and empties back into the marsh. The stream is about 15 feet across and a sewer empties into it at the bridge near the Soldiers' Home, from where we started. The vegetation consisted chiefly of algae which was directly in the stream. Also found live crayfish and many small minnows.

Vegetation covered with *Eucrangonyx* and beetles; damsel fly larvae were also quite abundant; small cat fish, dragon fly larvae, several snails, cat fish fry and the numerous skins of crayfish which had been shed.

Towing No. 1 was taken below the bridge along the shore. The current was moderate; depth about 8 inches; sewer contamination present. Air temperature 32 degree C. Water temperature 32 degrees C. Found *gammarus*, *diatoms*, and *arcella*.

Towing No. 2 was taken from a quiet pool banked off from the main channel by rocks. Found *cyclops*, *arcella*, *difflugia* and *diatoms*. Life very sparse.

Towing No. 3 was taken from a quiet pool in the creek below the cemetery, the spot being well shaded. Contamination from all the sewers from the cemetery and below was present at this point. No vegetative forms were present.

1. *Annulata* (*Nais*).
2. *Amoeba proteus*.
3. *Diatoms* (numerous).
4. *Rotifera* (*Brachionus entzii*) numerous.
5. *Paramecium*.
6. *Arcella*.
7. *Euglenoidea* very abundant and this is indicative of sewage contamination; encysted forms abundant also.

More forms found here and the species were more numerous than at the points from which the two preceding towings were taken.

Down about 150 feet the vegetation was chiefly of a chara-like plant. Rapids were located below the second point of collection. In the rapids we found snails (numerous) larvae cases of midges, nematodes, beetles.

From rock on bottom: plannaria, caddice fly cases, bryozoan, snail eggs, fly larvae, egg case of water beetle, leech and hydra.

Air temperature was 30 degree C. and that of the water was 35.

LAKE ERIE PLANKTON.

July 27, 1916.

Towing No. 1 at surface.

3 *Vorticella* on blue-green algae (Anabaena Flos-aquae).
2 *Diatoms*.

Towing No. 2. ½ distance to bottom—10 feet.

12 *Nauplius*.
2 *Cyclops*.
1 *Bosmina*.
18 *Vorticella* on *Anabaena Flos-aquae*.

Towing No. 3 taken from the bottom—20 feet.

4 *Daphnia hyalina*.
65 *Cyclops*.
20 *Nauplius*.

There were few forms found at the surface, more numerous at the middle and bottom, greatest number at the bottom. The adult cyclops most numerous at the bottom while the nauplius stage was found to be most abundant ½ distance to the bottom.

Vorticella seemed to be very fond of the blue-green algae, *Anabaena flos-aquae.*

SANDUSKY BAY PLANKTON.

July 27, 1916.

Towing No. 1 at surface.	*Towing No. 2 ½ distance to bottom.*
Cyclops.	*Ceratium.*
Nauplius.	*Cyclops.*
Ceratium (numerous).	*Difflugia.*
Vorticella.	*Daphnia kalbergensis.*
Rotifera (numerous).	*Nauplius.*

Great abundance of animal life throughout Bay.

STARVE ISLAND.

July 25, 1916.

Starve Island is located about 20 miles from Cedar Point and about one mile from Put-in-Bay. The island is made up of about ¾ of an acre of limestone and only a slight amount of vegetation occurs on the northeast corner (Plate II).

This island is the nesting place of both the common and black tern and all ages of the birds were found. The youngest ones were found protecting themselves from the sun's heat by keeping in the shade of rocks. This was also a striking example of protective coloration. Found one garter snake and this was the extent of life on the island.

ABANDONED QUARRY—MARBLEHEAD, OHIO.

July 15, 1916.

Abandoned quarry at Marblehead, three or four years old, a typical rock bottom pond. Observations and reading were taken at three stations. Breezy and very bright sunlight.

Station 1.

Located about 50 feet above dock near the center of the pond. Rocky bottom and only a slight trace of algae. Depth 7 feet, 4 inches.

Temperature.

Surface	28 C.
½ dis. to bottom	27 C.
Bottom	21 C.

Carbon dioxide content.

At surface	1 c. c. per M.
At bottom	7 c. c. " "
2 ft. below surface	5 c. c. " "
7 ft. below surface	5 c. c. " "
½ ft. below surface	3 c. c. " "

No. 1 towing taken from the surface.

No. 2 towing taken from the bottom.

No. 3 sample was taken by pumping from the bottom into a net which was tied at the narrow end or outlet of the pump and then the net was carefully washed.

No. 4 towing taken from the bottom.

Station 2.

Located just off the dock. Depth 10 feet. Turbidity 9 feet.

Temperature.
28 C. at surface.
27 C. ½ distance to bottom.
27 C. at bottom.
No carbon dioxide present at surface.
2 c. c. per M. at bottom.
1½ c. c. per M. 7 feet below surface.
7 c. c. per M. 5 feet below surface.

No. 5 deep towing off dock.
No. 6 surface towing off dock.
No. 7 ½ distance to bottom from dock straight across to other side.
No. 8 surface towing from side to side.

Station 3.

At entrance of undercut from Lake through which undercut the pond is kept supplied with water. This point is supposed to be the deepest part of the pond but sounding proved that the pond was the same depth throughout.

Depth..............7ft. 4in.
Turbidity........7ft. 4in.

Temperature.
28 C. at surface.
28 C. ½ distance to bottom.
27 C. at bottom.

No. 9 deep pond dredging.
Carbon dioxide.
At surface..........1 c. c. per M.
At bottom..........5 c. c. per M.

Sunfish were found in the pond and also one stickleback. These fish had been thrown into the pond by fishermen. In pools, cut off from the main part we found water beetles and water striders. In pools not quite cut off from the shallow pools we found an abundance of algae upon which there were numerous beetles (*Hydrophyllidae*) and many small snails. Given below is a summary of the different towings with forms, quantity and quality found in each towing.

No. 1 Towing.

1. *Bosmina*	1
2. *Diatom*	1

No. 2 Towing at bottom.

1. *Nauplius*	3
2. *Bosmina*	2

No. 4 Towing.

1. *Ceratium longicorne*	24
2. *Nauplius*	3
3. *Cyclops*	5
4. *Bosmina*	11
5. *Daphnia*	4

3. *Nematoda*	1
4. *Ceratium longicorne*	672

No. 3 Towing taken by pumping.

1. *Cypris*	4
2. *Diatoms*	5
3. *Difflugia*	1
4. *Ceratium longicorne*	10

No. 6 Towing.

1. *Bosmina*	11
2. *Nauplius*	9
3. *Ceratium longicorne*	68
4. *Rotifera skeleton*	1

No. 8 Towing.

1. *Cypris*	1
2. *Bosmina*	1
3. *Nematoda*	1

No. 5 Towing.

1. *Cypris*	1
2. *Rotifera*	2
3. *Bosmina*	28
4. *Nauplius*	4
5. *Cyclops*	7
6. *Ceratium longicorne*	80
7. *Difflugia*	3

No. 7 Towing.

1. *Nauplius*	10
2. *Bosmina*	14
3. *Arcella*	8
4. *Cylcops*	2
5. *Vorticella*	7
6. *Ceratium longicorne*	563

Our Birds in November.

BY BROTHER ALPHONSUS, C. S. C.

November is the month when the last of the summer residents and spring migrants depart for their winter homes. Fox Sparrows, Titlarks and Myrtle Warbles, among the migrants, are the last to leave us. And among the summer residents, the Robin, Kingfisher, Bronzed Grackle, Killdeer, Vesper Sparrow, Golden-crowned Kinglet and Logger-head Shrike are the latest to depart. The species that are most frequently seen in November are the Song Sparrow, Goldfinch, Cardinal, Blue Jay, Crow, Downy Woodpecker, Redheaded Woodpecker, White-breasted Nuthatch, Chickadee, Snowbird, Purple Finch and Tree Sparrow. Those that are less frequently observed are the Brown Creeper, Hell Diver, Prairie Horned Lark, and Mourning Dove.

SONG SPARROW

Melospiza melodia

This favorite songster is quite hardy, and remains north in small numbers all winter. In November the bird may be heard calling near its summer haunts along the shores of lakes and streams; and occasionally on bright days, the cheery notes of its song will greet the bird-lover. Not infrequently the pedestrian will startle a